Model Evaluation Workshop

Kissimmee Watershed Hydrologic Assessment, Modeling, and Operations Planning

The MODFLOW Option

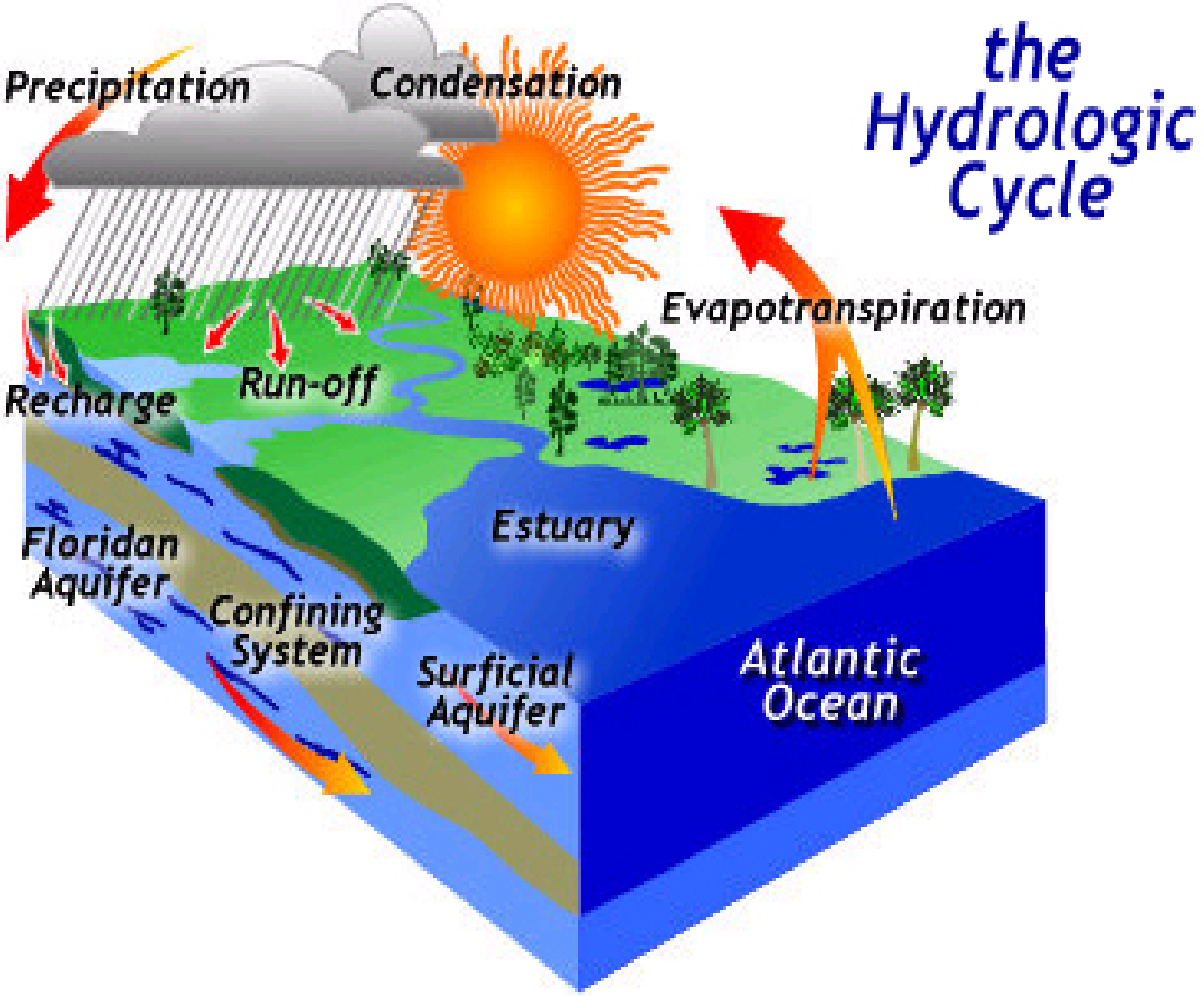
Presentation Objectives

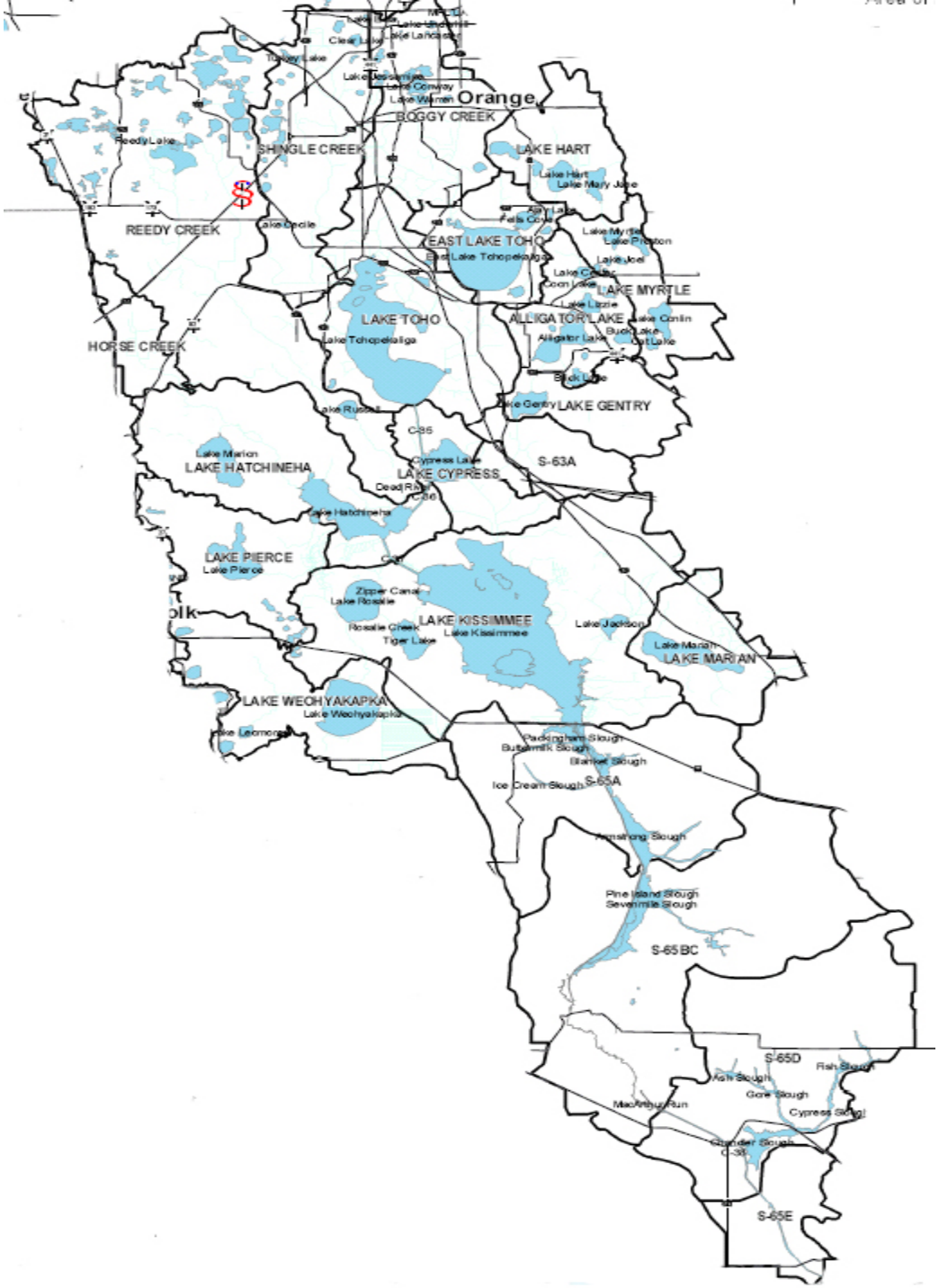
- Present MODFLOW'S basic functionality
- THE "MOD" IN MODFLOW: standard and not so standard MODFLOW packages
- MODFLOW PLUS: options for coupling MODFLOW with surface water models
- Discussion

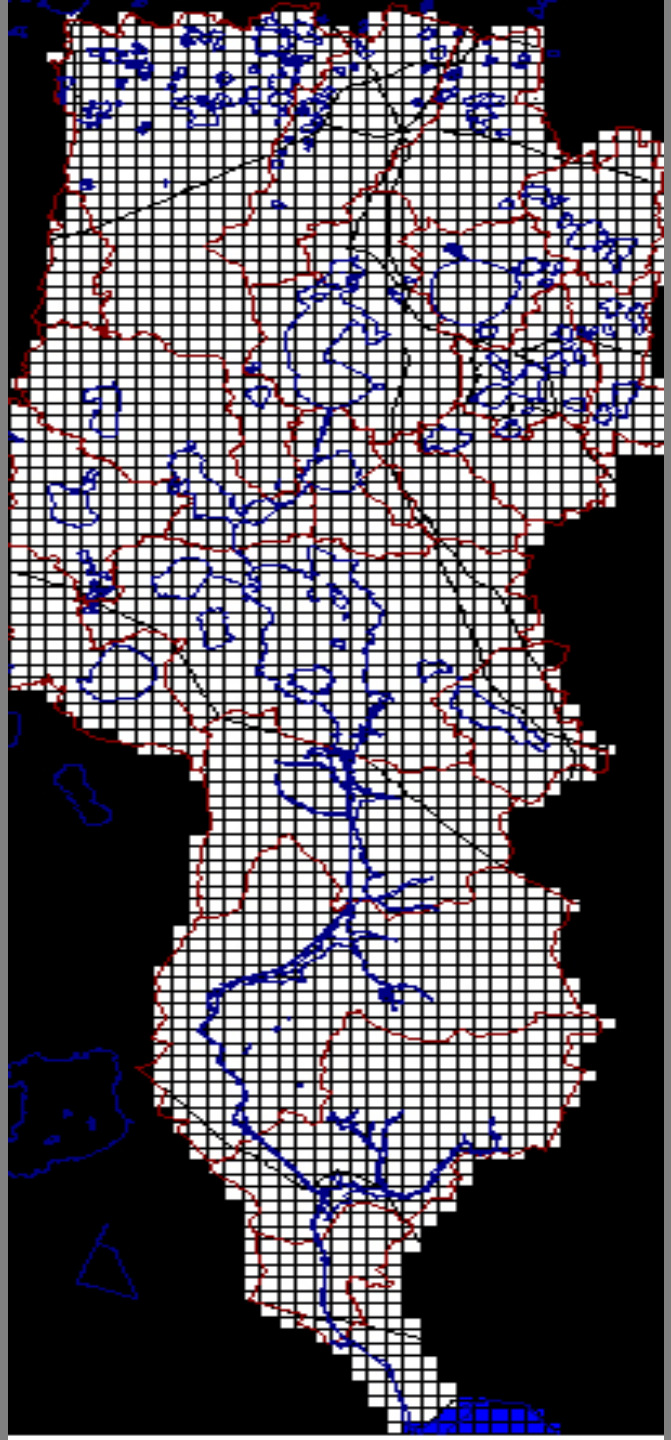
MODFLOW

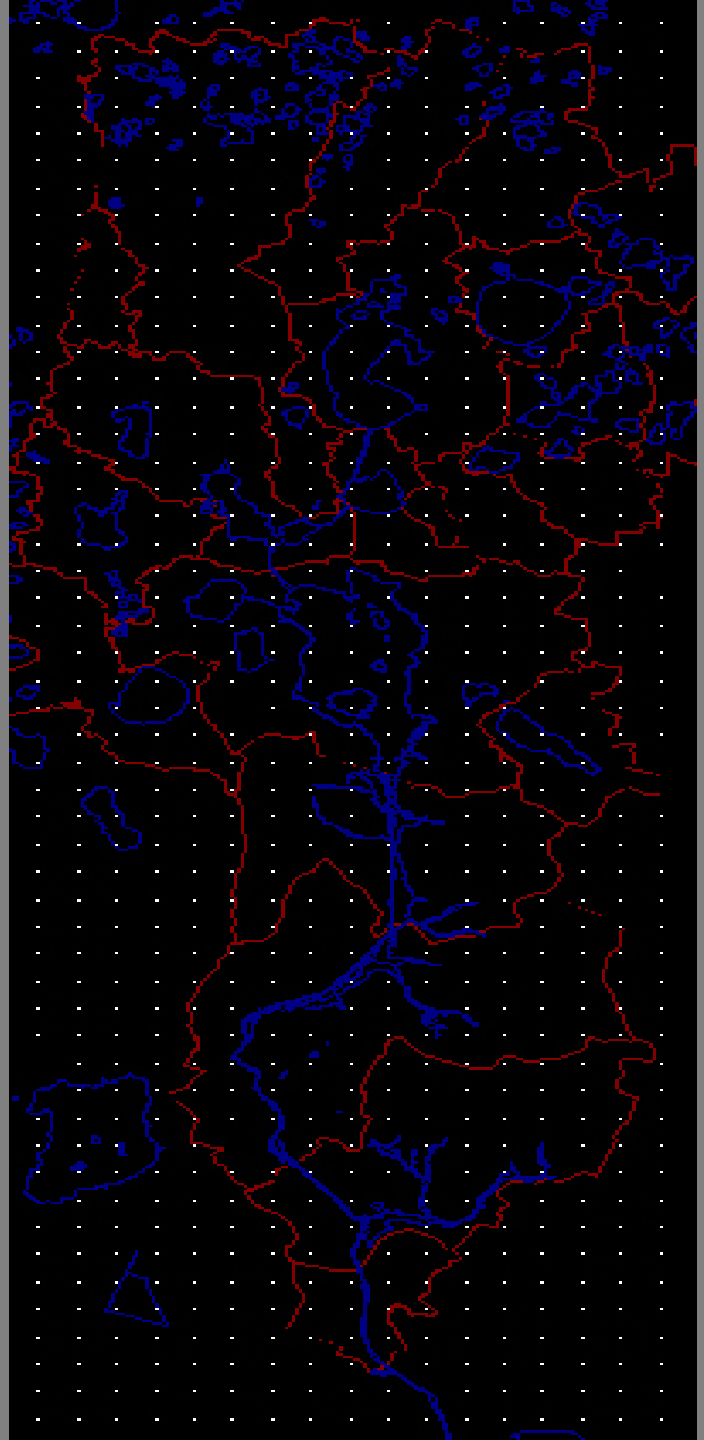
$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right)+\frac{\partial}{\partial z}\left(K_{zz}\frac{\partial h}{\partial z}\right)-W=S_s\frac{\partial h}{\partial t}$$

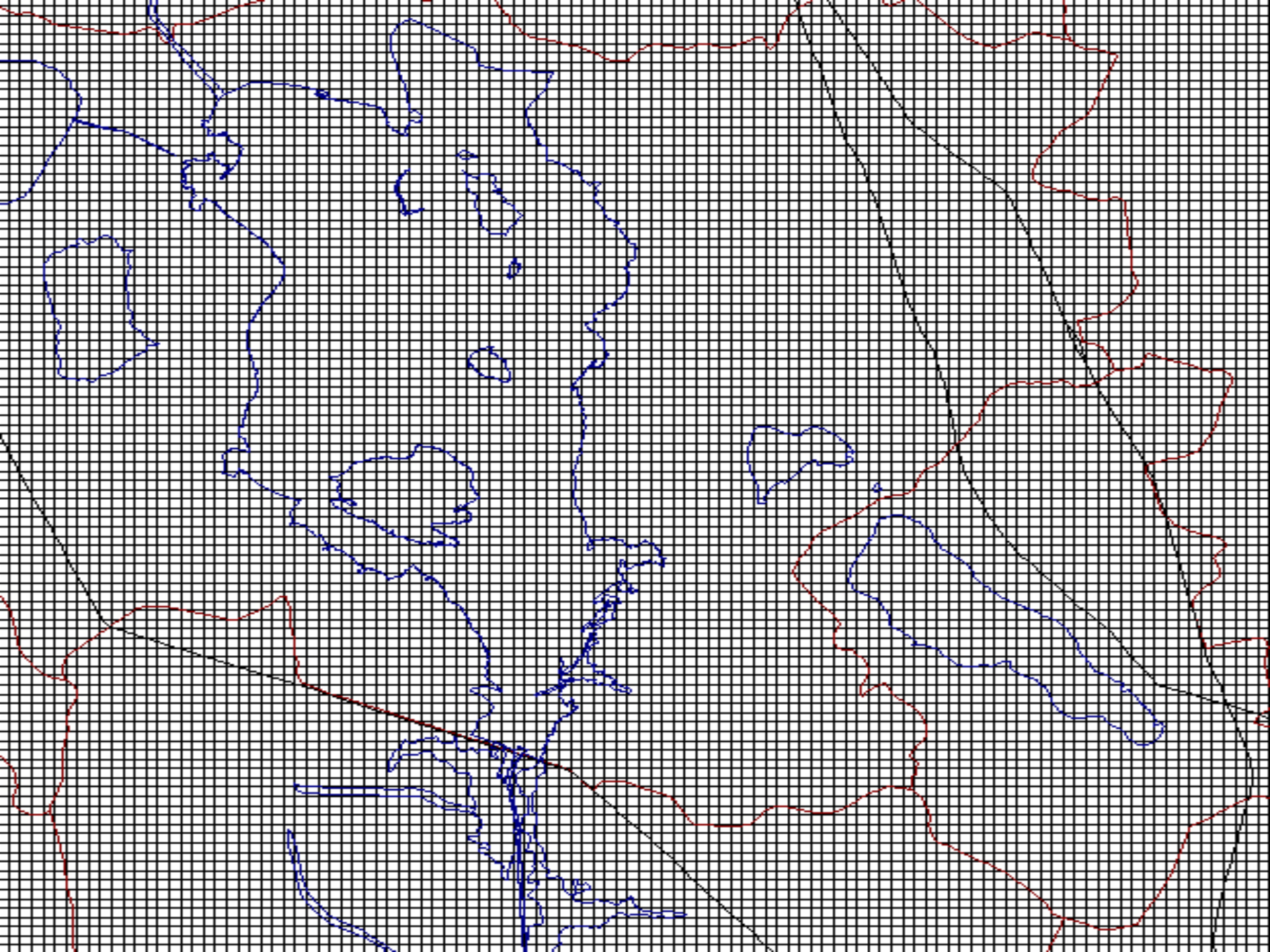
where K_{xx}, K_{yy}, and K_{zz} are defined as the hydraulic conductivity along the *x*, *y*, and *z* coordinate axis,*h* represents the potentiometric head, *W* is the volumetric flux per unit volume being pumped, S_s is the specific storage of the porous material and *t* is time.

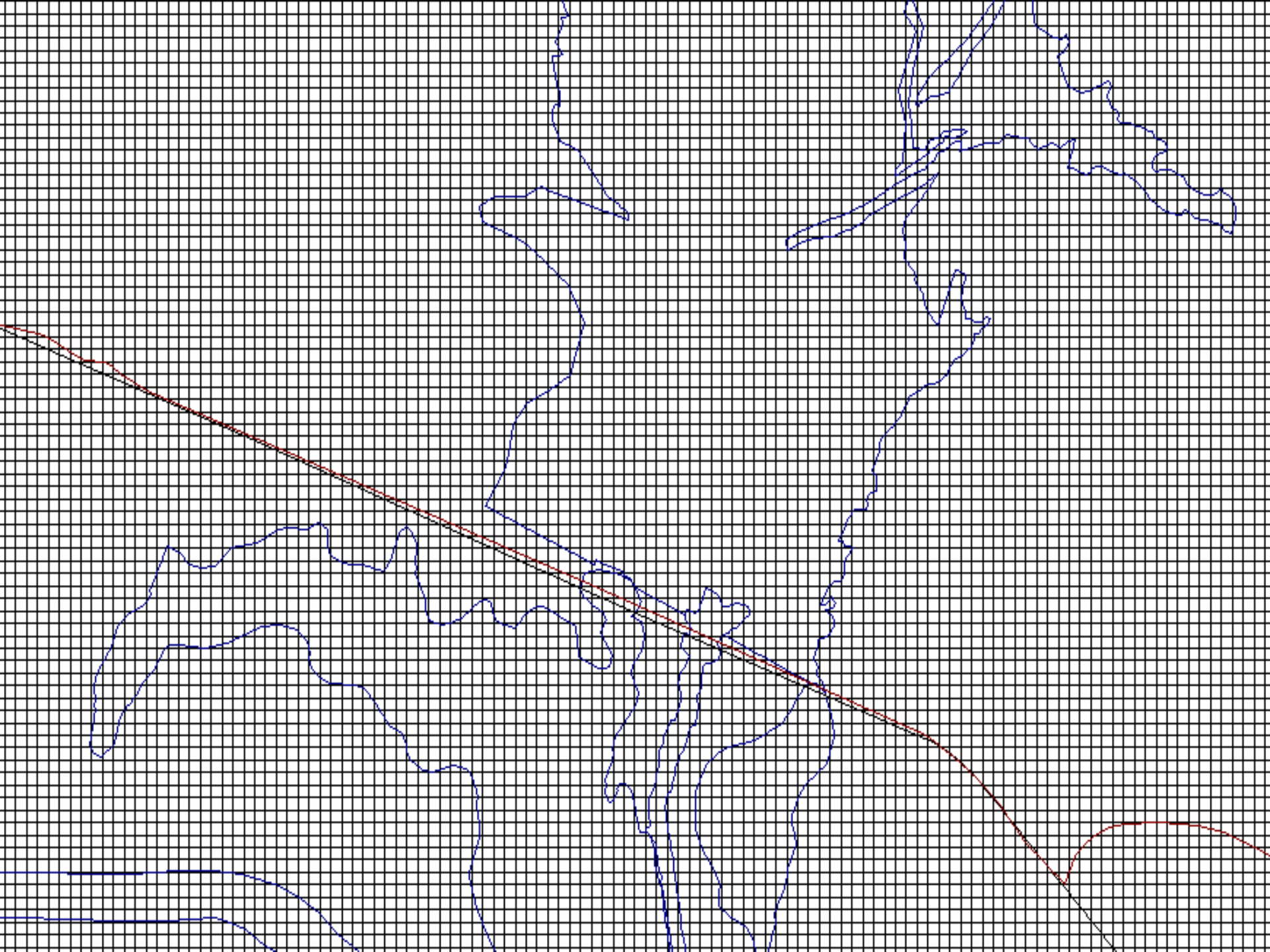

the Hydrologic Cycle
Precipitation
Condensation
Evapotranspiration
Run-off
Recharge
Estuary
Floridan Aquifer
Confining System
Surficial Aquifer
Atlantic Ocean

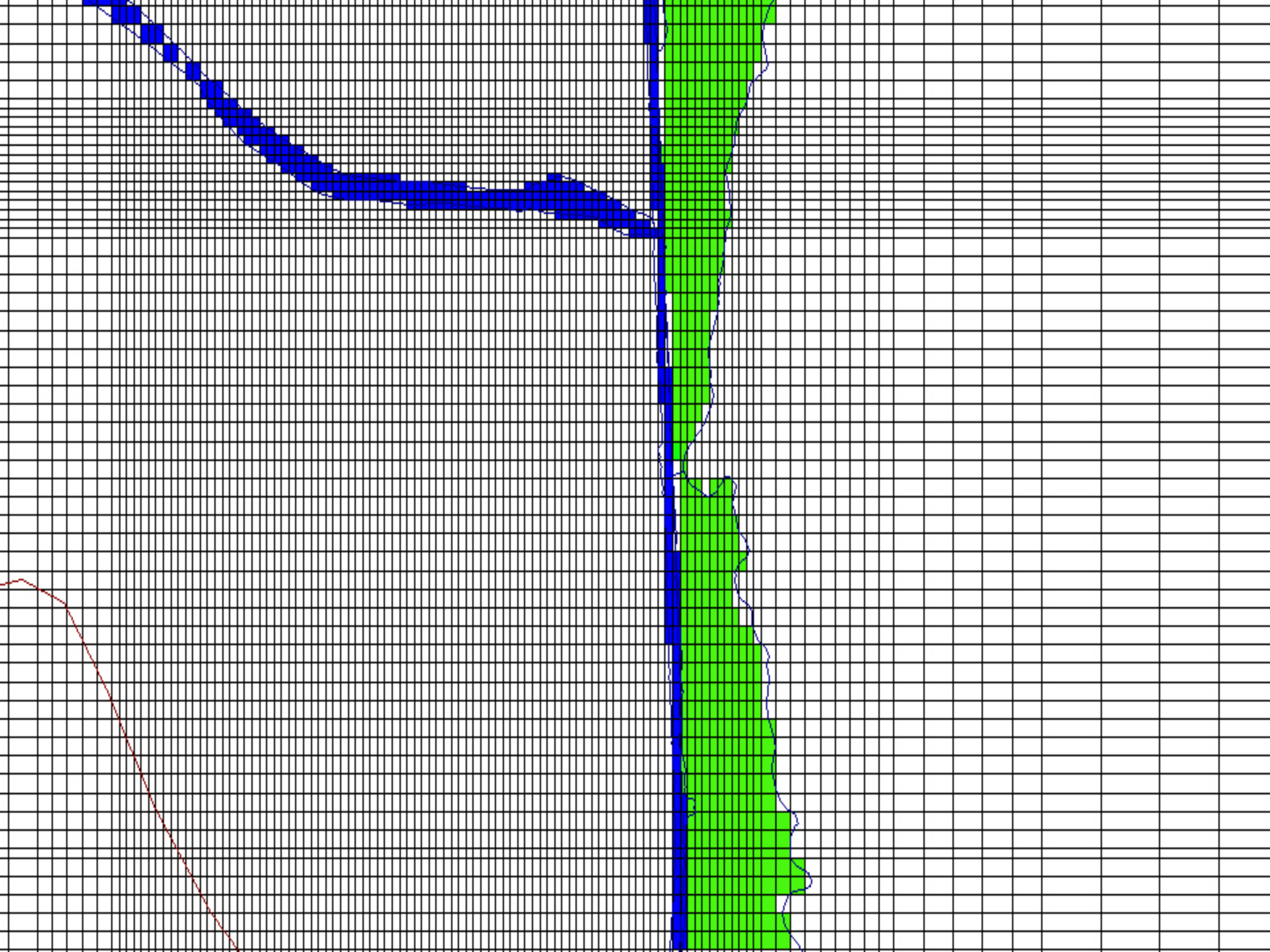

Orange
BOGGY CREEK
SHINGLE CREEK
REEDY CREEK
HORSE CREEK
LAKE HART
EAST LAKE TOHO
LAKE TOHO
LAKE MYRTLE
ALLIGATOR LAKE
LAKE GENTRY
LAKE CYPRESS
LAKE HATCHINEHA
LAKE PIERCE
LAKE KISSIMMEE
LAKE MARIAN
LAKE WEOHYAKAPKA
S-63A
S-65A
S-65BC
S-65D
S-65E
C-35
C-38

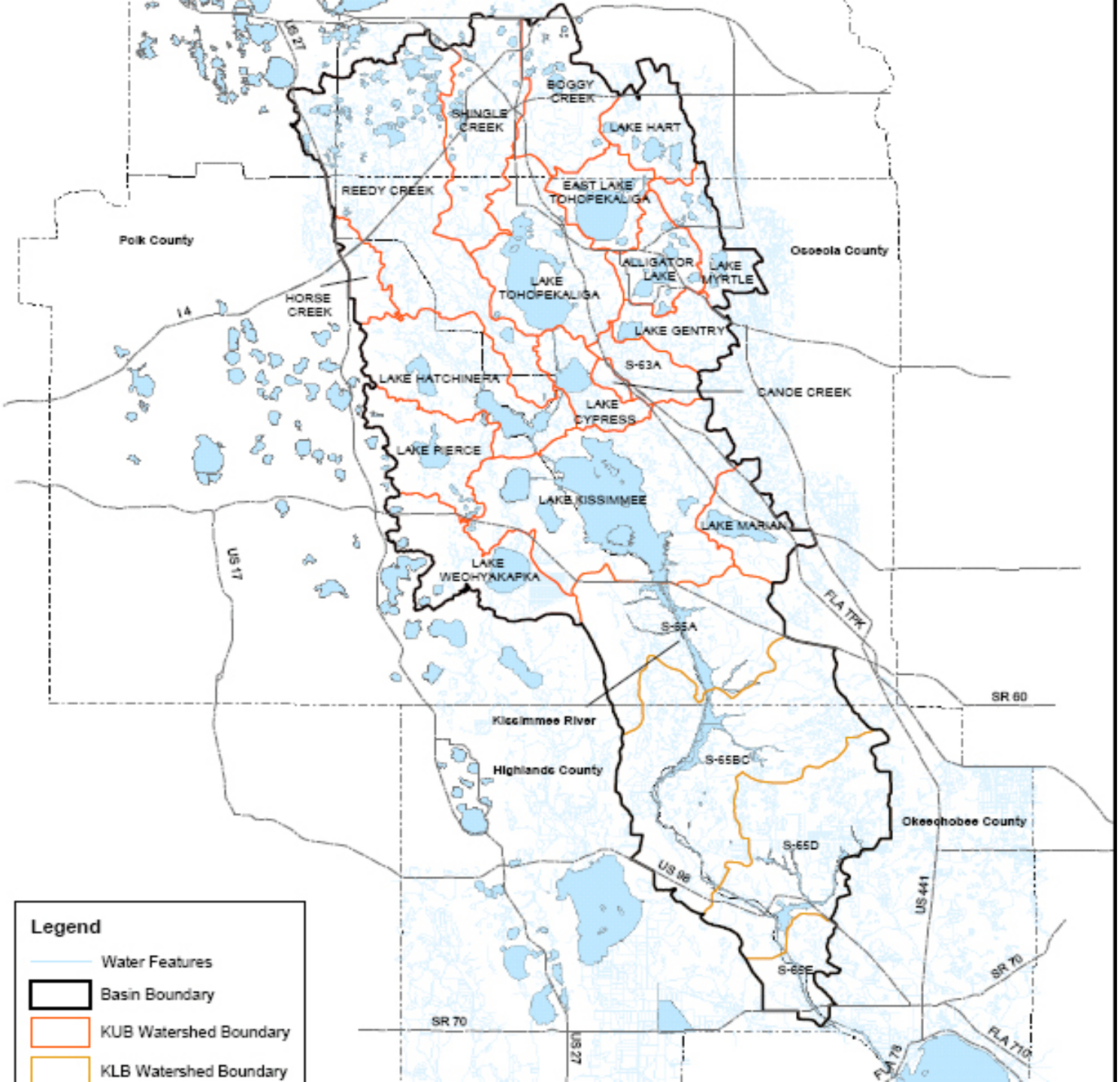











BOGGY CREEK
SHINGLE CREEK
LAKE HART
REEDY CREEK
EAST LAKE TOHOPEKALIGA
Polk County
Osceola County
ALLIGATOR LAKE
LAKE MYRTLE
LAKE TOHOPEKALIGA
HORSE CREEK
LAKE GENTRY
S-63A
LAKE HATCHINEHA
CANOE CREEK
LAKE CYPRESS
LAKE PIERCE
LAKE KISSIMMEE
LAKE MARIAN
US 17
LAKE WEOHYAKAPKA
FLA TPK
S-65A
SR 60
Kissimmee River
Highlands County
S-65BC
Okeechobee County
S-65D
US 98
US 441
S-65E
SR 70
SR 70
US 27
FLA 710
Legend
Water Features
Basin Boundary
KUB Watershed Boundary
KLB Watershed Boundary

MODFLOW

PROS AND CONS

Pros

- **MODFLOW is the most widely used and supported groundwater model in the world.**
  - **Thoroughly tested.**
  - **Widely used in Florida and by District.**
  - **Numerous developers and modifiers.**
  - **No significant learning curve.**

Pros

- KB has already been modeled using MODFLOW
- Time step flexibility
- Handles groundwater explicitly
- Many options for handling surface water

Cons (Stand Alone)

- **MODFLOW lacks some functionality that may be important to project objectives**
  - **No surface water runoff**
  - **No unsaturated flow**
  - **Limited ability to simulate control structures**

Cons (Stand Alone)

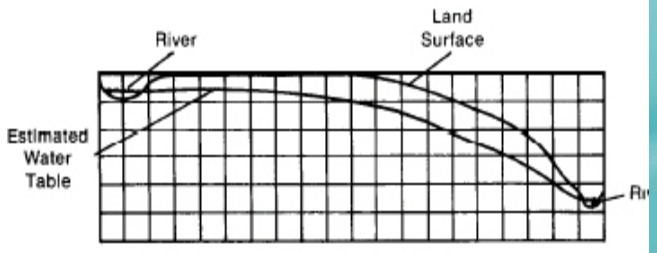
- Groundwater flow and surface water flows have some scale and time incompatibilities
- Finite Difference Limitations

MODFLOW Package Name (documented in Harbaugh and others, 2000, or in references cited in that work)	File Type of MODFLOW-2000 Name File	MT3DMS iSSType Code for Sinks/Sources
Basic	BAS6	n/a
Block-Centered Flow	BCF6	n/a
Layer Property Flow	LPF1	n/a
Hydrogeologic Unit Flow	HUF2	n/a
Horizontal Flow Barrier	HFB	n/a
Time-Variant Specified Head Boundary	CHD	1
Well	WEL	2
Drain	DRN	3
River	RIV	4
General Head Dependent Boundary	GHB	5
Recharge	RCH	7*
Evapotranspiration	EVT	8*
Streamflow-Routing	STR	21
Reservoir	RES	22
Specified Flow and Head Boundary	FHB	23
Interbed Storage	IBS	24
Transient Leakage	TLK	25
Lake	LAK	26
Multi-Node Well	**MNW**	**27**
Drain with Return Flow	**DRT**	**28**
Evapotranspiration with Segments	**ETS**	**29**

MODFLOW PACKAGES

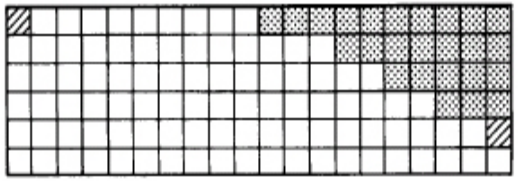
- **Standard Packages**
  - **Recharge (rch)**
  - **Evapotranspiration (evt)**
  - **Well (wel)**
  - **Drain (drn)**
  - **River (riv)**
  - **Stream (sfr)**
  - **Lake (lak)**

Recharge and ET



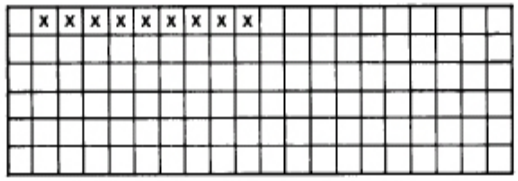
Vertical Cross-Section Showing Field Situation With Finite Difference Grid Superimposed

a



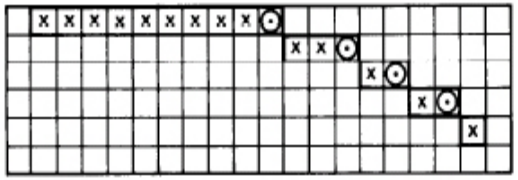
Status of Cells at End of Simulation

b



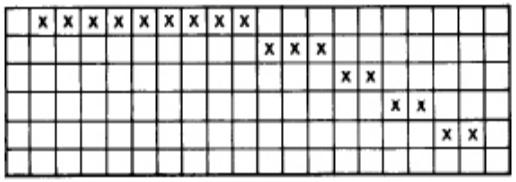
Cells Which Receive Recharge Under Option 1

c



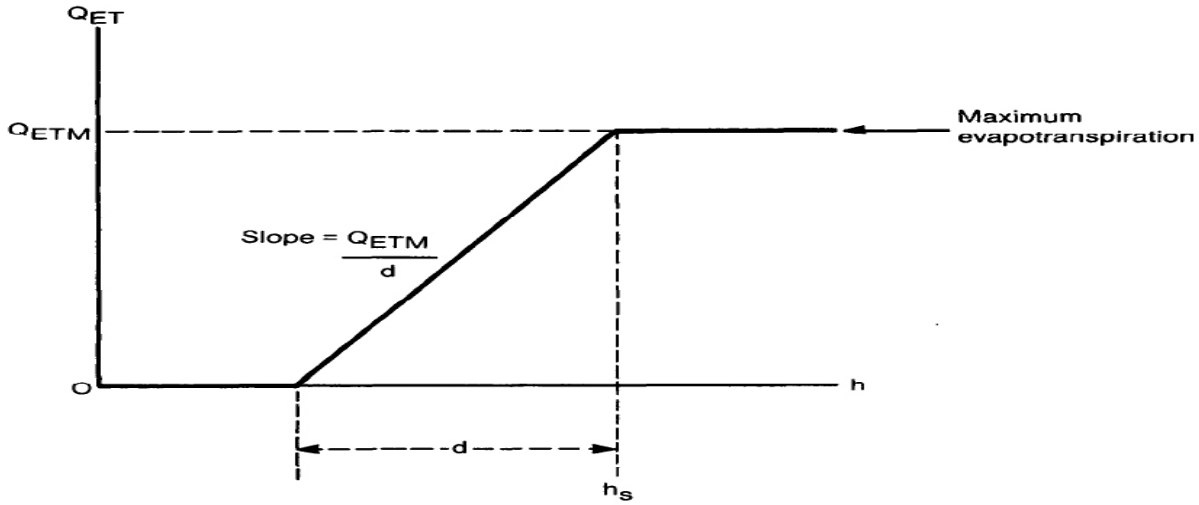
Cells Which Receive Recharge Under Option 2

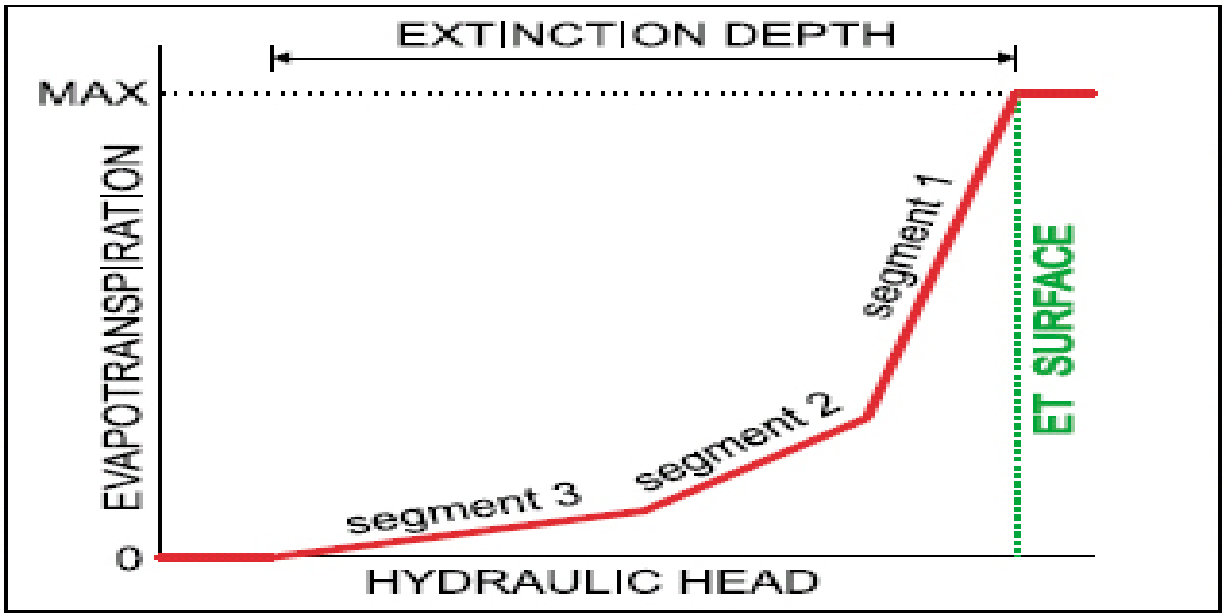
d



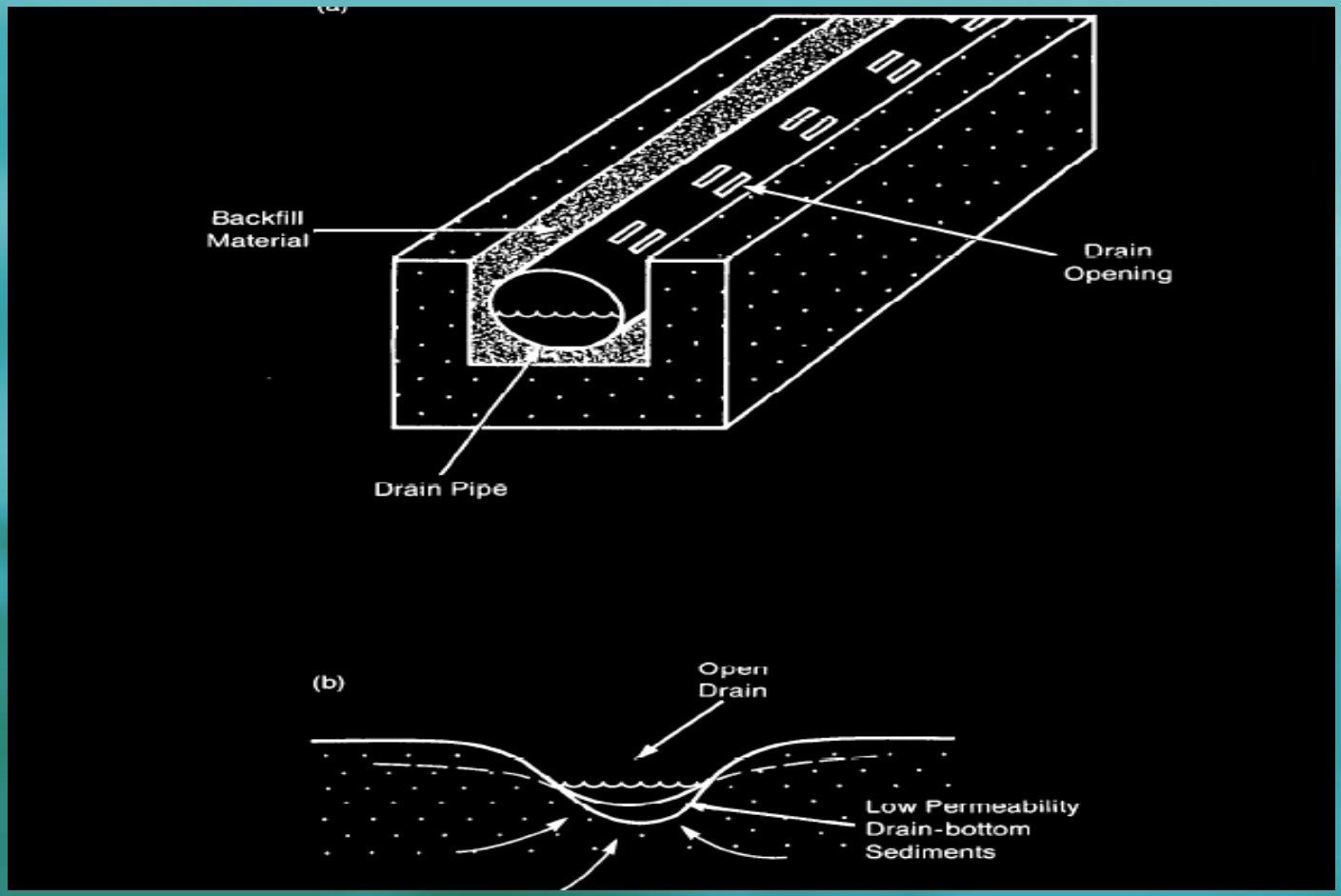
Cells Which Receive Recharge Under Option 3

e





Drain Package



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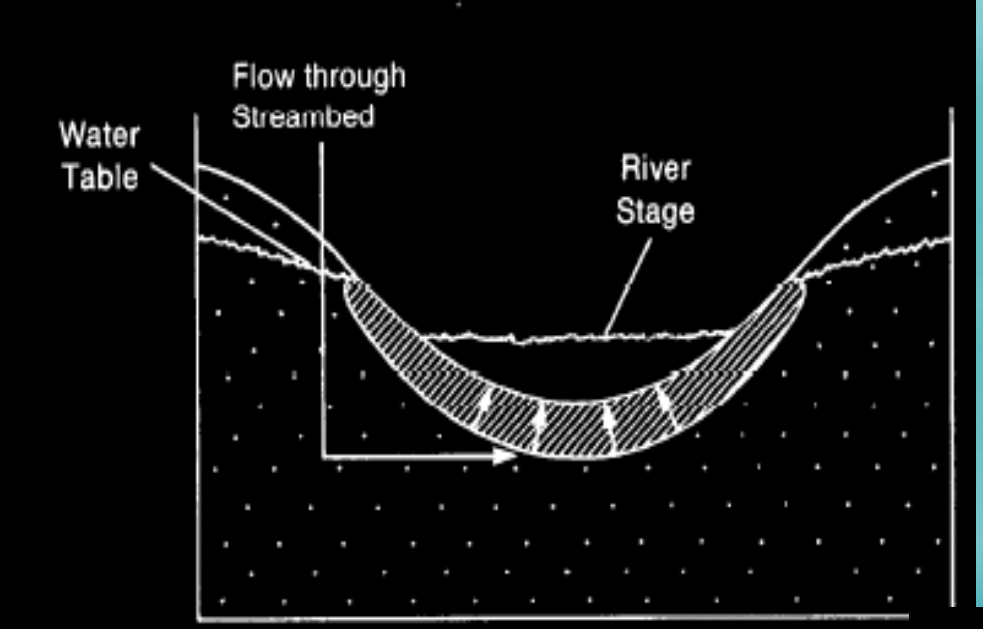
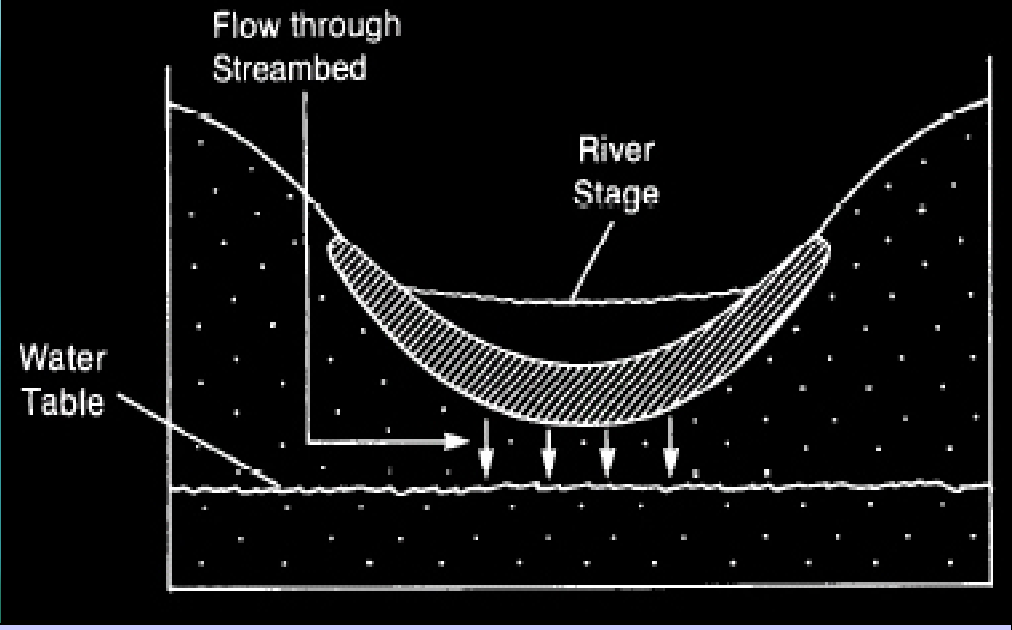
River Package





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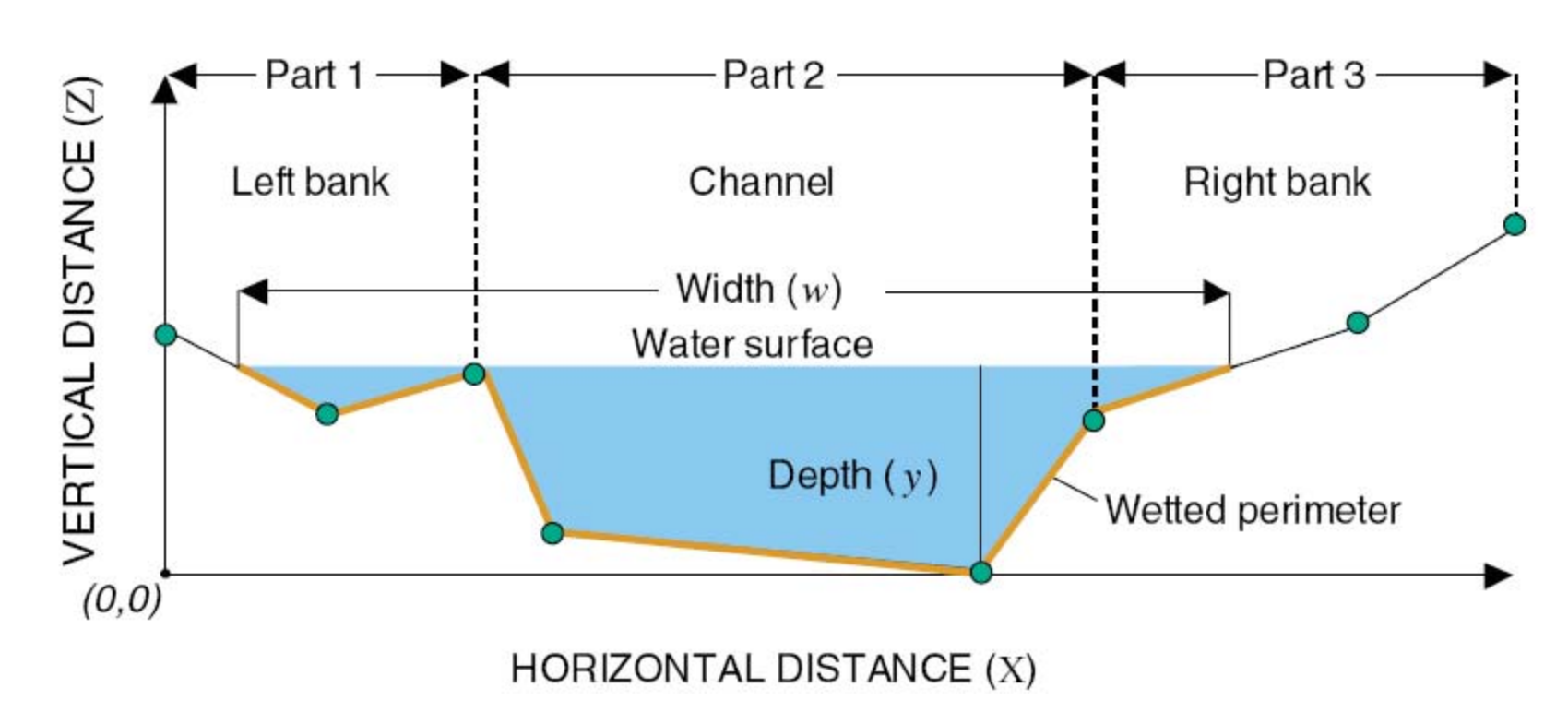
Stream Package



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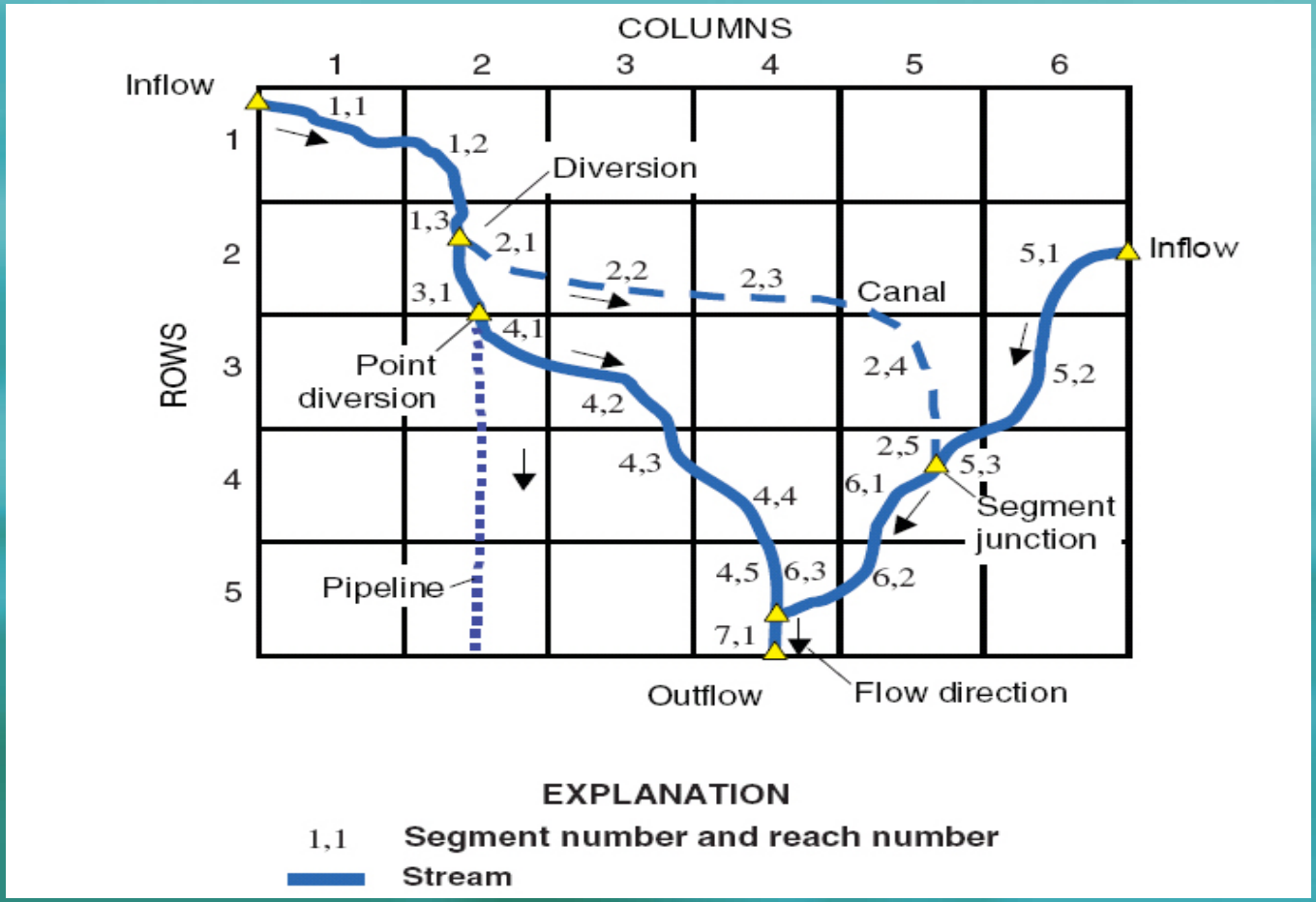
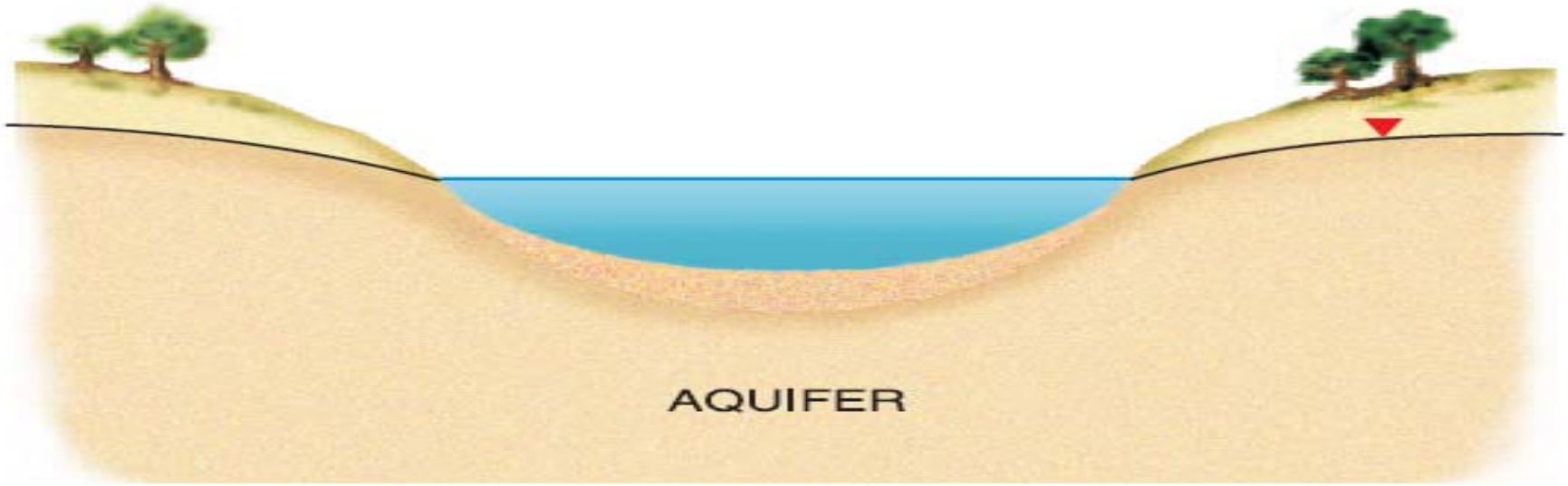
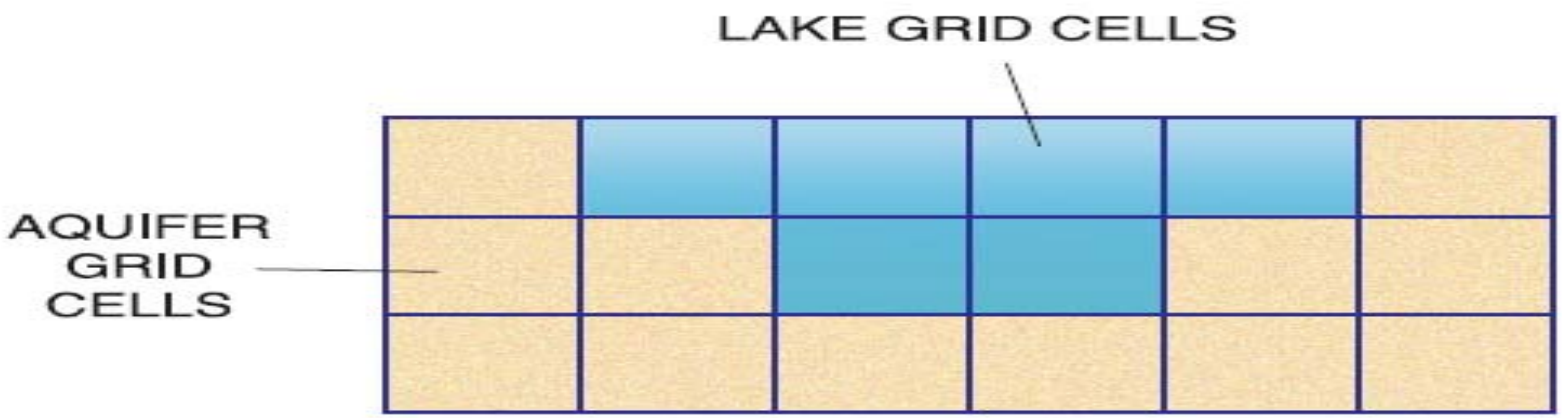
Stream Package

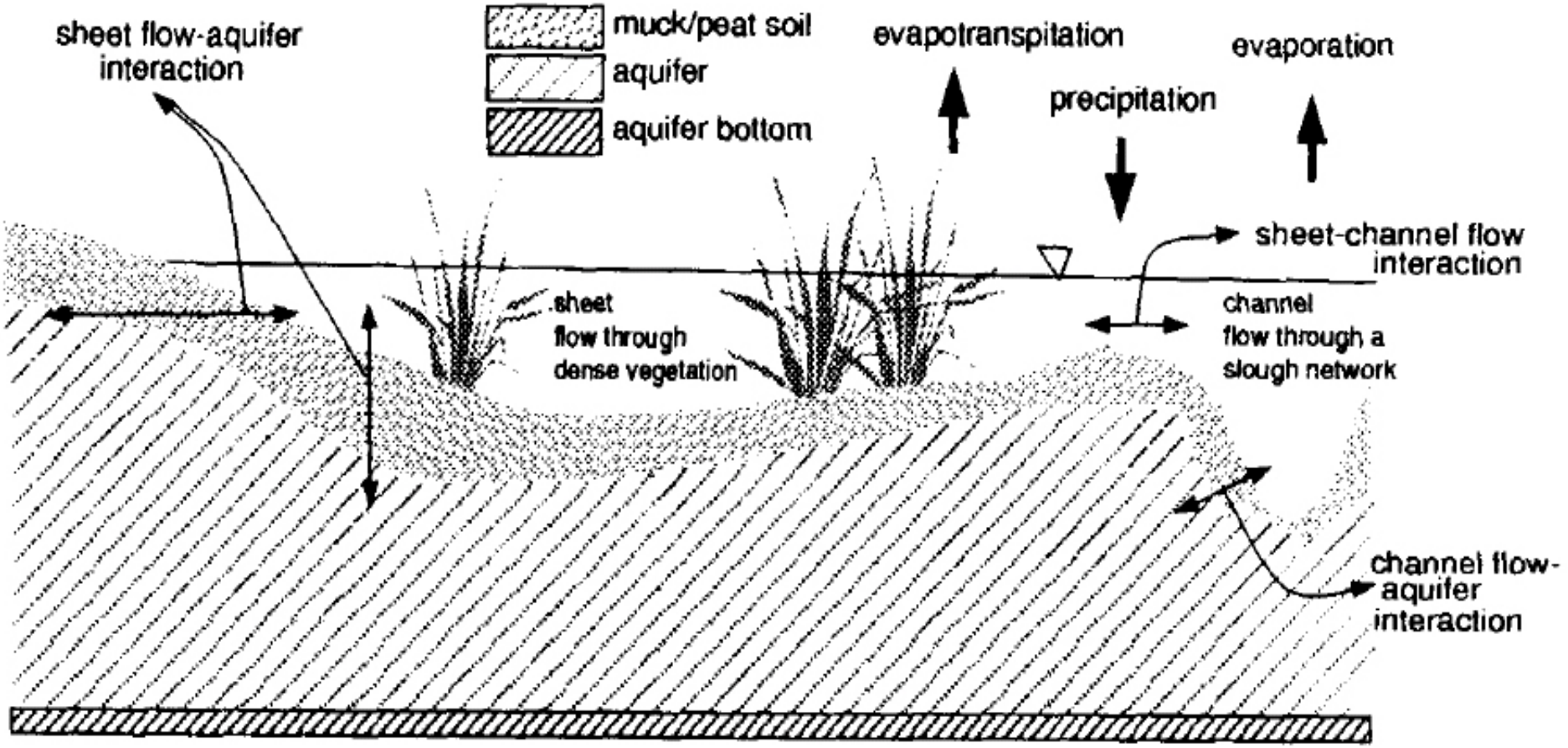


Lake Package

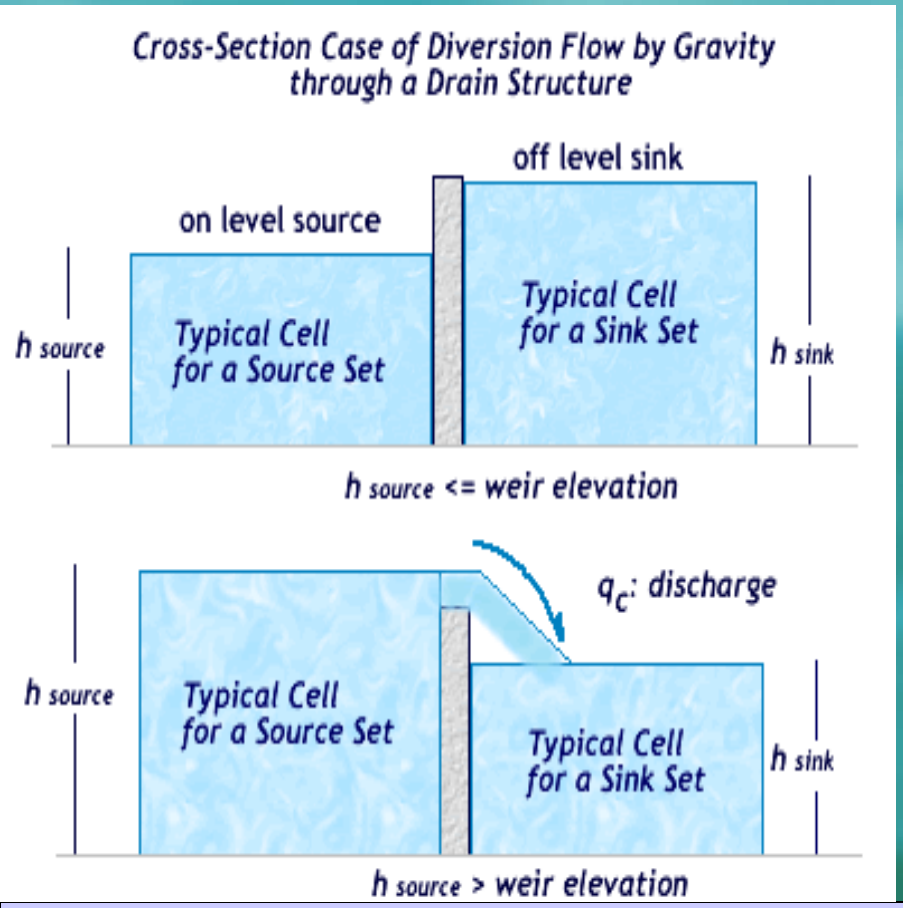


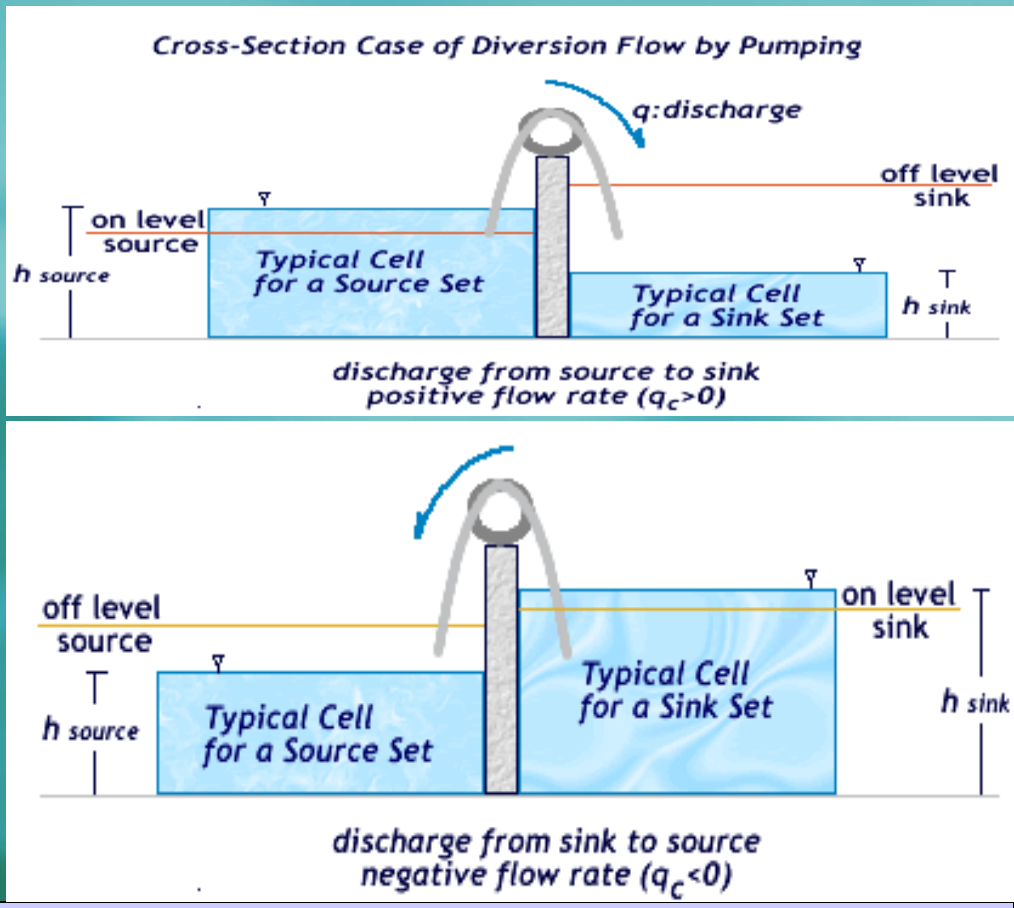


Wetland Package



Diversion Package





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MODFLOW PLUS

COUPLING MODFLOW WITH SURFACE WATER MODELS

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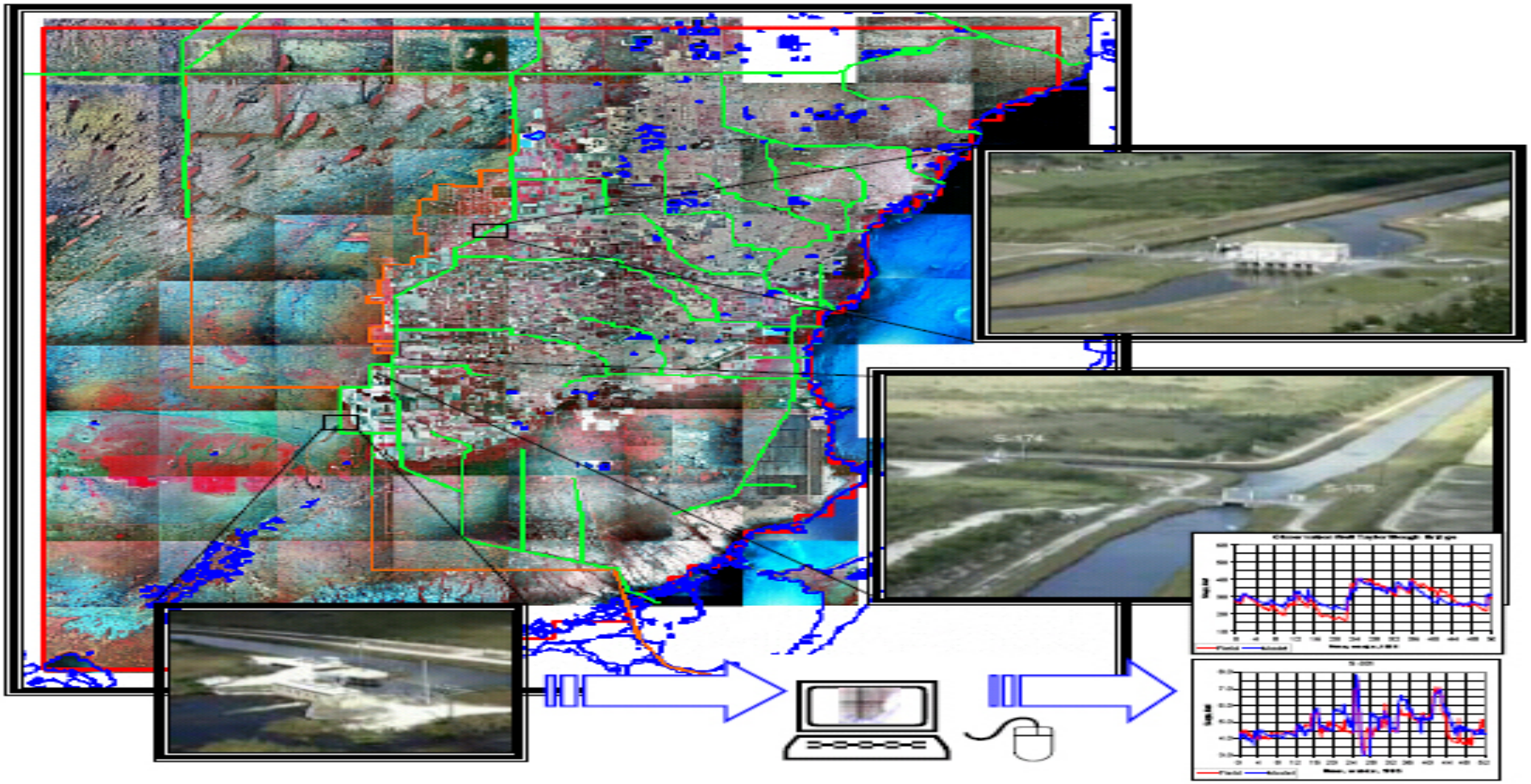
MODBRANCH

MODFLOW + BRANCH

3-D Groundwater **Open Channel Flow**

Leakance

Calibration and Verification of the MODBRANCH Numerical Model of South Dade County, Florida

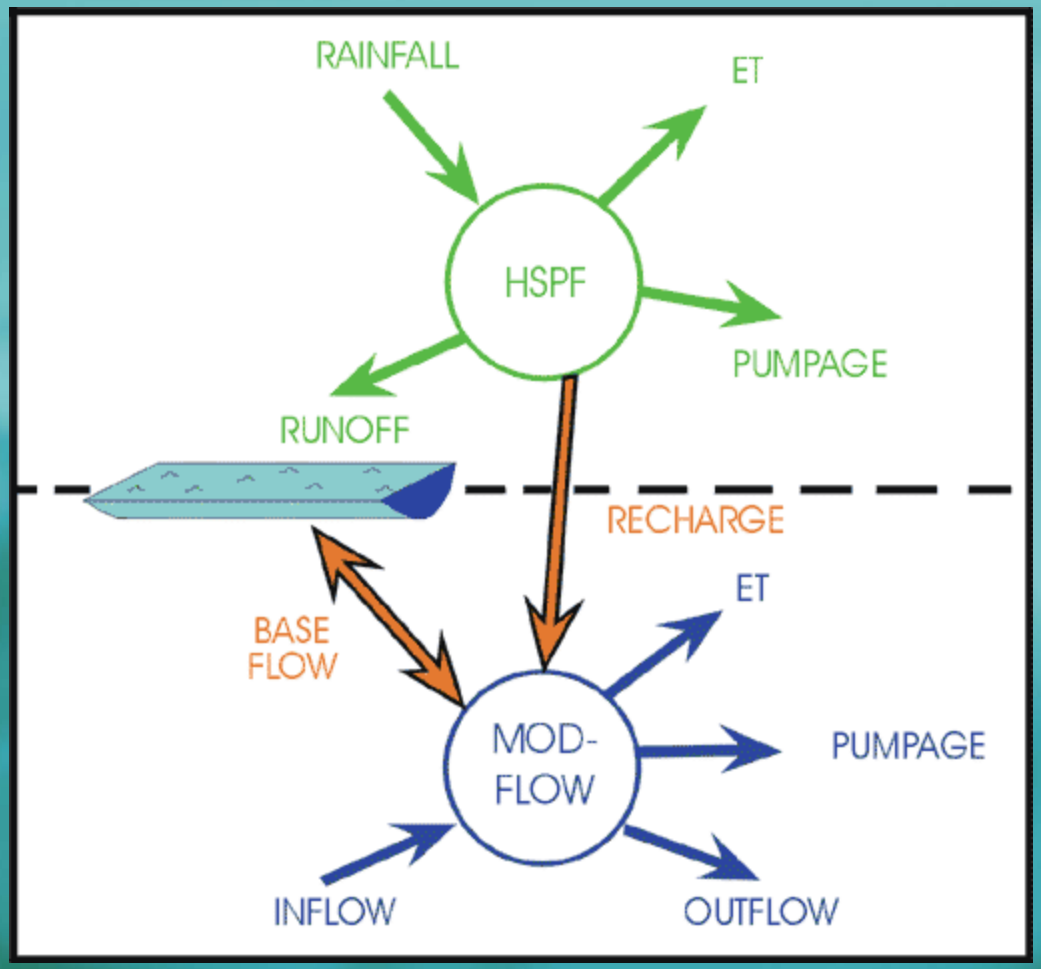


Robert A. Evans, Jr.

U. S. Army Corps of Engineers
Jacksonville District
February 2000

MODFLOW AND HSPF

FHM ISGW IHM



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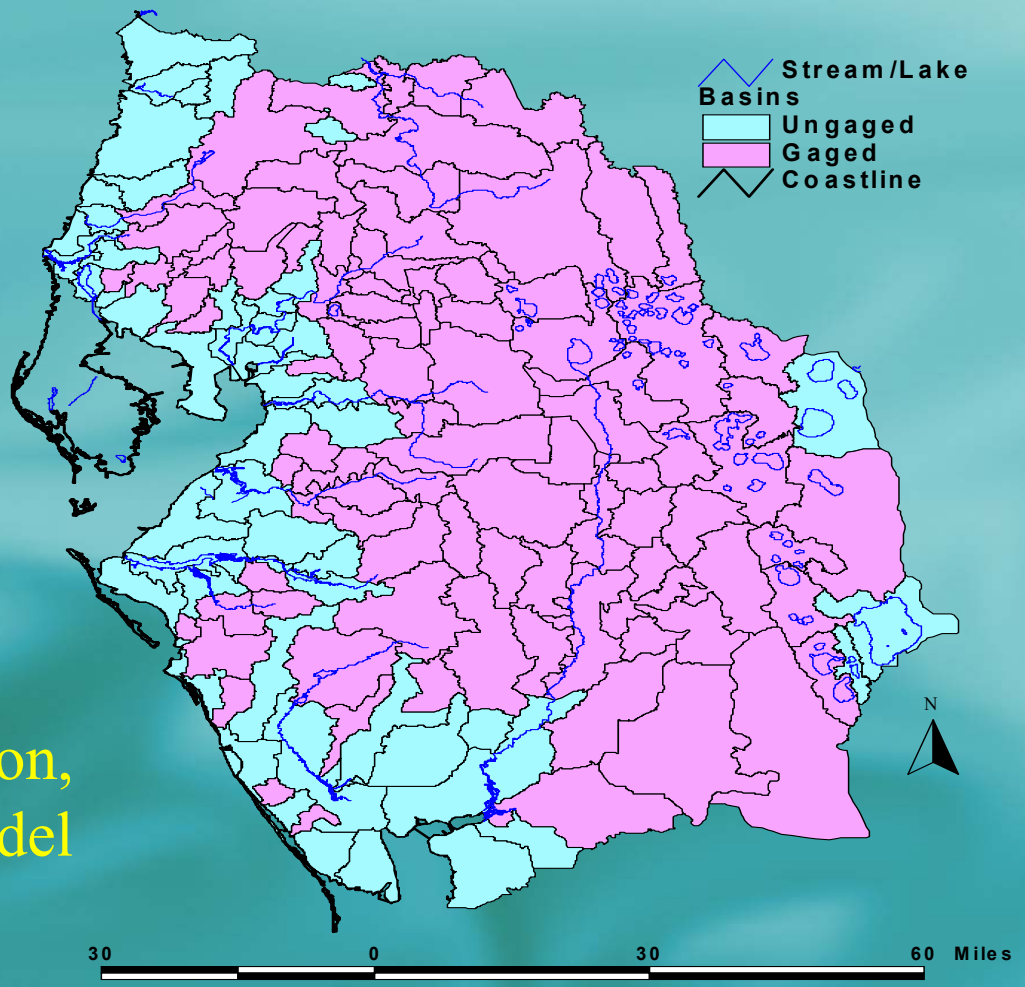
SWFWMD Southern District Model

HSPF,
MODFLOW pre-calibration,
1st phase of integrated model



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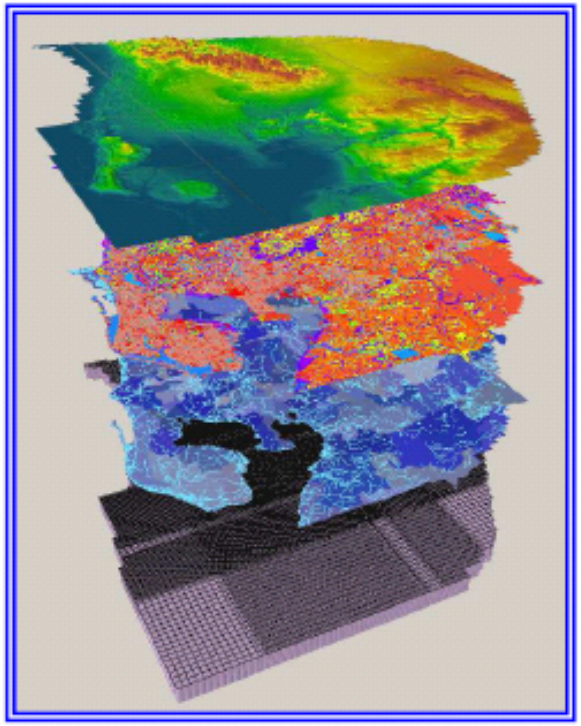
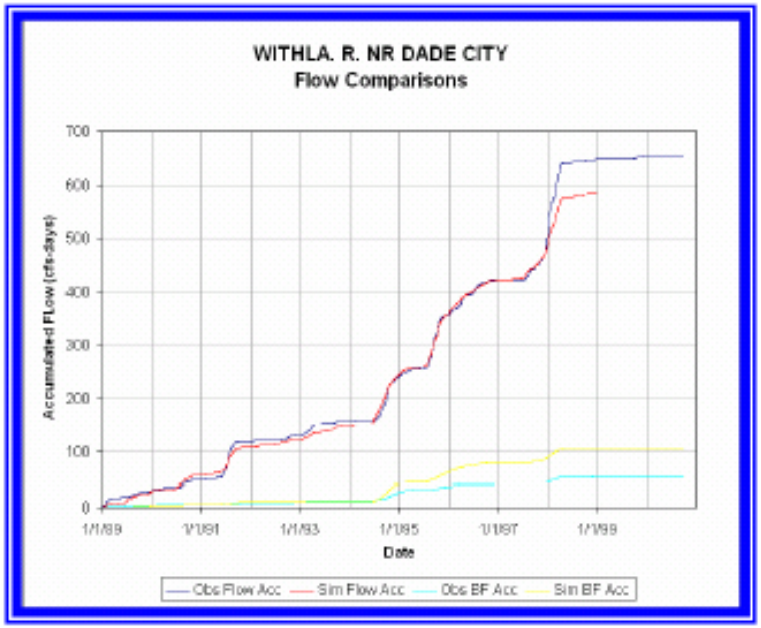
The Integrated Hydrologic Model (IHM) and Application in the North Tampa Bay Region





SUMMARY

- MODFLOW on it's own will probably not be sufficient to meet the project objectives.
- MODFLOW combined with a surface water model can meet project objectives.
- A MODFLOW platform for groundwater flow in the Basin model will be an efficient use of existing models.

DISCUSSION